DESIGNING OF AN ECG SIGNAL ACQUISITION SYSTEM AND ANALYZING EFFECT OF SLOW MUSIC ON AUTONOMIC NERVOUS SYSTEM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT

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CERTIFICATE

This is to certify that the thesis entitled "**DESIGNING OF AN ECG SIGNAL ACQUISITION SYSTEM AND ANALYZING EFFECT OF SLOW MUSIC ON AUTONOMIC NERVOUS SYSTEM** "submitted by **Mr. RUDRA DUTT SHUKLA** in partial fulfilment of the requirements for the degree of **Bachelor of Technology in Biomedical Engineering** embodies the bonafide work done by him in the final semester of his degree under the supervision of the undersigned. The thesis or any part of it has not been submitted earlier to any other University / Institute for the award of any Degree or Diploma.

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ABSTRACT

In recent times there has been a large increase in the development and designing of the portable and personal healthcare devices. These devices are not only very effective but also very cost effective. In the present study, we focused our research to design and develop a low cost portable ECG acquisition system. The acquired data and readings from the device can be stored in any computer with the help of customised software and can be sent to medical professional and experts for further diagnostics and detection. This ECG acquisition device can be useful to record the vital cardiac parameters of the patient. The device is easy to handle. After developing the device successfully, it was further used for ECG signal acquisition of the male volunteers for conducting research on effect of slow music on the cardiac physiology. The results indicated an increase in the parasympathetic dominance as the volunteers were made to listen to music. This indicates that slow music affected the sympatho-vagal balance.

Keywords: ECG Acquisition System, Music, Heart Rate Variability, Healthcare Devices, Autonomic Nervous System

1. INTRODUCTION

The recording and analysis of the biosignals have gained much attention in the last decade. This is because of the change in the fields of medical instrumentation and pharmaceutical, which has permitted the medicinal specialists to retrieve and extract more data from the physiological signals. In recent times, there has been an immense increase in designing and development of devices, which are capable of fast and easy recordings and can be used in personal healthcare applications.

Amongst various personal healthcare devices, devices that are used to extract and retrieve information about the cardiac health have received much more attention. This is because there has been a significant increase in the occurrence of cardiovascular diseases during these days. So it is crucial to regularly monitor the cardiovascular parameters of the body for early detection and diagnosis of any pathological conditions of the body. Keeping the above facts in mind, in this study we report the designing and development of an ECG amplifier circuit. The circuit can be useful for recording the vital heart parameters of the patient. The readings from the ECG amplifier circuit can be recorded and stored on any computer with the help of customized software. The data which is saved and recorded in the computer can be sent to a healthcare professional by email for further analysis.

Music has been accounted for to adjust the physiological and the mental conditions of people [1]. This outcomes in the adjustment of the cardiovascular action [2]. The fundamental purpose behind the adjustment in the physiological action of the heart has been portrayed because of the intercession in the autonomic nervous system. In the most recent decade, there has been a massive increment in the anxiety and the tension of the persons. This, thus, has brought about the

increment in the quantity of the infections connected with the psychosomatic issue [3]. To ease such conditions, music treatment has been proposed because of its capacity to change the movement of the autonomic nervous framework. Despite the fact that the music treatment has been found to change the passionate conditions of the patients, the system of music treatment is still a hazy area for the scientists [4]. Music has been found to bring out a specific kind of enthusiastic state. Numerous specialists have considered the impact of distinctive sorts of music on the passionate conditions of the volunteers. In the greater part of the studies, the reaction of the volunteers in regards to their enthusiastic states was recorded. Tragically, no other physiological reactions were considered. Because of this reason, clashing results were acquired. In a percentage of the late writing, it was observed that listening to music reductions the thoughtful action with the comparing increment in the parasympathetic movement [5]. The thoughtful and the parasympathetic exercises, which shape a coordinated piece of the autonomic nervous framework, can be examined non-obtrusively by concentrating on the heart rate variability (HRV) [6]. The investigation of the HRV helps in comprehension the dynamic connections among the thoughtful and parasympathetic framework, which continually changes because of the inward and the outer jolts.

In the present study, we have attempted to comprehend the impact of moderate music on the action of the autonomic nervous system. The action of the autonomic nervous system was examined by contemplating the heart rate variability. Linear classifier ANOVA was utilized to foresee the important features.

OBJECTIVE

- To design and develop an ECG signal Acquisition Circuit.
- To analyse effect of the slow Music on Autonomic Nervous System and Cardiac Health using it.

2. LITERATURE REVIEW

2.1 Heart Rate (HR)

Heart rate or heart beat is the number of heartbeats per unit of time, beats per minute (bpm). Heart rate changes with the varying body conditions and depends on various parameters, for example, it changes with the body's need for oxygen and excretion of carbon dioxide. Heart rate is very useful parameter that is used by various medical professionals and experts to track and diagnose different heart problems.

2.2 Heart and Its Functions

The Heart is crucial and vital organ of the body. It pumps blood throughout the body. It takes deoxygenated blood from the whole body and pumps back the oxygenated blood (received from the lungs) to the body. The heart is situated in the middle of the thorax, a little bit to the left side, and surrounded by the pair of lungs.

The Heart is comprised of four chambers. These four chambers are two atriums (right atrium and left atrium) and two ventricles (left ventricle and right ventricle). The right atrium gets blood coming back to the heart from the whole body. That blood experiences the right ventricle and is pumped to the lungs. In the lungs, blood is oxygenated and retreats to the heart through the left atrium. After this blood experiences the left ventricle and is pumped again to be dispersed to the entire body through the arteries.

Below are the events that take place in the heart on each heartbeat.

1. Atrium begins to depolarize.

2. Atrium depolarization.

3. Ventricles begin to depolarize at apex. Atrium re polarizes.

4. Ventricles depolarization.

5. Ventricles begin to re polarize at apex.

6. Ventricles re polarization.

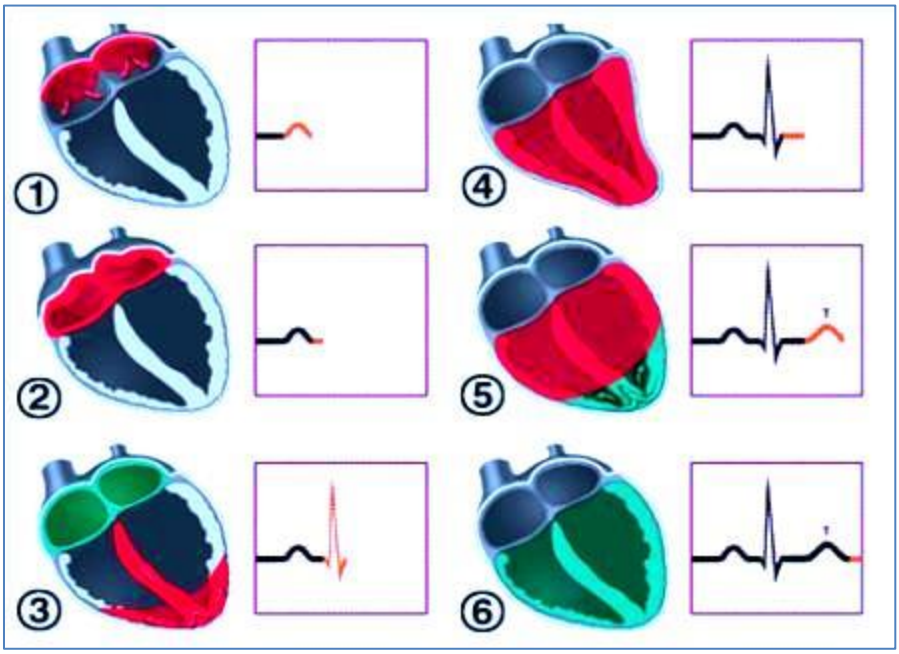

Figure 1 - Subsequent events that occur in the heart on each heartbeat[15]

In the figure given below, the signal shows a typical heart signal. In this signal, the general heart activity and voltages that are generated in the heart by heart muscles can be found. Different peaks in this signal represent different heart activity. The most important part of the given below

figure is typical QRS complex. It is used for various analyses of cardiac physiology and heart rate variability.

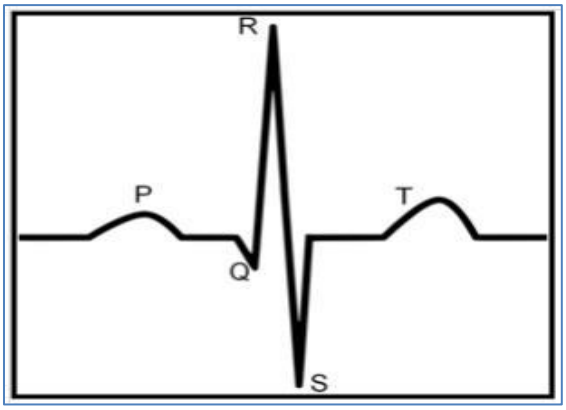

Figure 2 - A typical heart signal[16]

T wave and QRS complex represent the action of ventricles. The atrium action is represented by the P wave. With the help of the array of this signal (PQRS), the heart rate can be obtained. Each time this signal is detected a heartbeat is obtained.

2.3 ECG Circuit and Its Components

A typical ECG circuit consist of various parts such as instrumentation amplifier, active and passive filters, right leg drive, etc.

The most important part of the circuit is instrumentation amplifier. It is used to amplify the weak signal of the ECG. It is imperative to amplify the weak signal to be able to use it for further processing. Due to this a high gain instrumentation amplifier with a high common mode rejection ratio (CMRR) is the primary requirement.

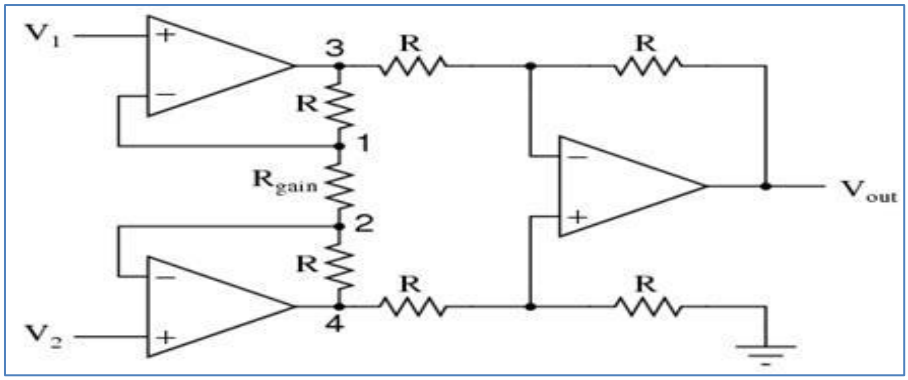

Figure 3 - A general representation of instrumentation amplifier[17]

Reasons to use instrumentation amplifier:

1- Get differential signal

2- High input impedance

3- High CMRR

The voltage between point 3 and 4 will be as -

$$V_{3\text{-}4} = (V_2 - V_1)\left(1 + \frac{2R}{R_{gain}}\right)$$

On the right-hand side of the circuit the regular differential amplifier then takes this voltage drop between points 3 and 4, and amplifies it by a gain of 1 (assuming again that all "R" resistors are of equal value).

Manipulating the above formula little bit, we can get the value for overall voltage gain of the instrumentation amplifier, which will be:

$$A_V = (1 + \frac{2R}{R_{gain}})$$

Since the ECG signal is exceptionally small and little in adequacy, it is greatly required that it ought to be enhanced. Anyway, filtering of the signal is likewise a discriminating and highly required assignment so that any twisting and noise can be expelled from the signal. Different sorts of noises, for example, noise from environment, noise from the peripheral equipment, 50Hz noise from the electrical cables can easily distort the weak ECG signal. So the usage of a fitting filter is highly needed in the ECG circuit outlining. A band pass filter is utilized to expel the noise from the signal. A notch filter can be utilized to uproot the 50Hz noise.

Apart from above-given components some other elements may also be required in the ECG circuit designing depending upon the acquisition procedure and output requirements. Some of these are right leg drive circuitry, voltage buffer circuitry, peak detection circuit, etc.

2.4 Heart rate variability (HRV)

Heart rate variability (HRV) is the physiological phenomenon of variety in the time intervals between heartbeats. It is measured by the variety of the beat-to-beat intervals. It depicts the variations between back to back heartbeats. The regulation instruments of HRV start from the thoughtful and parasympathetic sensory systems and, therefore, HRV can be utilized as a quantitative marker of the autonomic nervous system.

There are different terms used for heart rate variability, which include: "RR variability" (where R is a point relating to the top of the QRS complex of the ECG wave; and RR is the interval between progressive Rs), "cycle length variability", and "heart period variability".

Various Systems are used to recognize and calculate beats, and these are: ECG, circulatory strain, and the beat wave sign got from a photoplethysmograph (PPG).

Electrocardiogram (ECG) is viewed as predominant because it gives a clear and unmistakable waveform, which makes it easier and simple to avoid heartbeats not starting in the Sinoatrial hub. The expression "NN" is utilized instead of RR to accentuate the way that the transformed beats are "normal" beats.

Clinicians figure the general heart rate by counting the QRS complexes over an interval of one minute.

However, amid HRV examination the time gap between identical occasions in sequential heart cycles are considered – and how its value changes with the movement of time are noted. Also how the instantaneous heart rate changes with time is additionally found in the meantime.

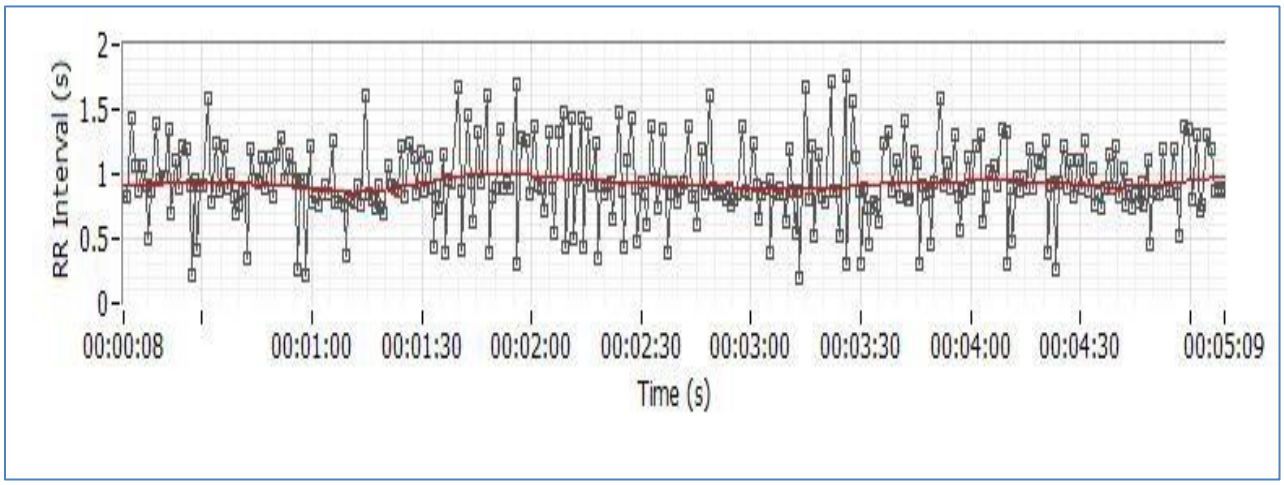

Figure 4 - The plot of RR intervals with respect to the time axis

Even though different techniques are used to recognize beats including EMG, pulse and so forth has been created, ECG is still thought to be a superior alternative because it gives clear waveforms, which enables easy removal of heartbeats which are not originating in the SA node.

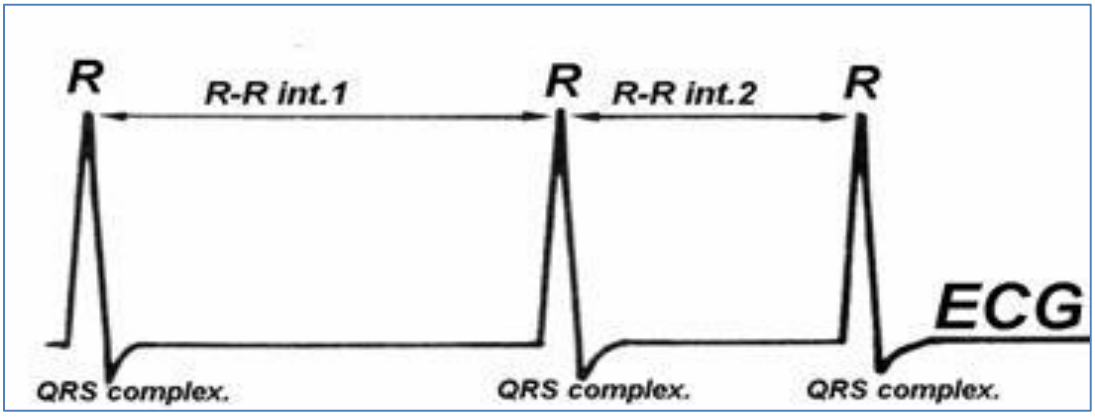

Figure 5 - QRS Complexes and RR intervals[18]

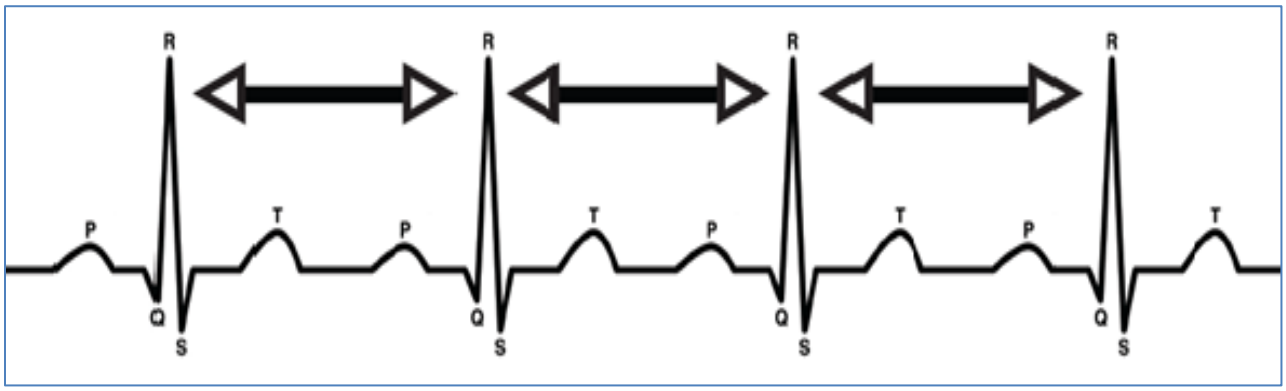

Figure 6 - HRV measurement by calculating time between R spikes[19]

2.5 Autonomic Nervous System (ANS)

The autonomic nervous system has two divisions:

1. Sympathetic

2. Parasympathetic

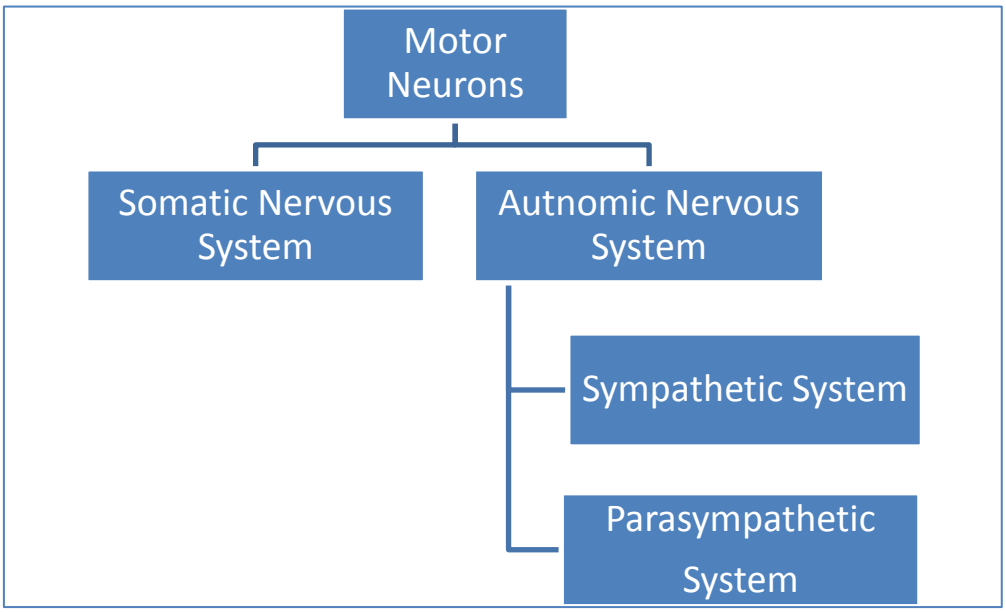

Figure 7 - Schematic representation of different Parts of Motor Neurons

2.6 Relation between HRV and ANS

Scientists have inspected the impact of feelings and emotions on the autonomic nervous system by the examination of heart rate variability, which serves as a dynamic correlation between autonomic balance and functional capacity.

In a normal and healthy volunteer, the sympathetic system fibers and parasympathetic system fibers innervate the Sinoatrial hub.

Parasympathetic innervations of the heart are intervened by the vagus nerve which causes a decrease in the SA hub in this manner diminishing the heart rate while stimulation and incitement by the sympathetic system causes an increment in the heart rate.

The nervous system is partitioned into two sections:

1. The Somatic nervous system which is accountable for intentional control of organs that mainly include muscles.

2. Autonomic Nervous System (ANS) otherwise called the instinctive/automatic system controls singular organ capacity and homeostasis and is liable to automatic control.

Along these lines the variability in the heart rate is because of the activity of collaboration and balance between the two branches of the Autonomic nervous system, which is primarily upheld through neural, mechanical, humoral and other physiological systems.

It (ANS) keeps up cardiovascular parameters in their most ideal ranges and grants suitable responses to change in inner or outside stimuli.

This harmony between the impact of the sympathetic system and the parasympathetic systems is known as the sympathovagal adjust and is accepted to be resounded in the beat-to-beat changes of the cardiovascular cycle. The heart rate is characterized by the complementary of the RR intervals with units of beats or pulsates/min.

2.7. Wavelet transformed analysis and its advantages

A waveform of limited or constrained span that has a zero average value is known as wavelet. Dissimilar to sinusoids that theoretically reach out from minus infinity to plus infinity, wavelets have a starting and an end.

Sinusoids are smooth and predictable and are great at portraying steady frequency (stationary) signals while Wavelets are unpredictable, of restricted term, and regularly non-symmetrical.

They are better at describing abnormalities, beats, and different occasions that begin and stop at the signal.

There are different types of wavelets exist those can be matched to the shape of required signal (of which wavelet transform is to be done).

If the required physical characteristics of given signal and particular wavelet family matched, that particular family of the wavelet is chosen for use.

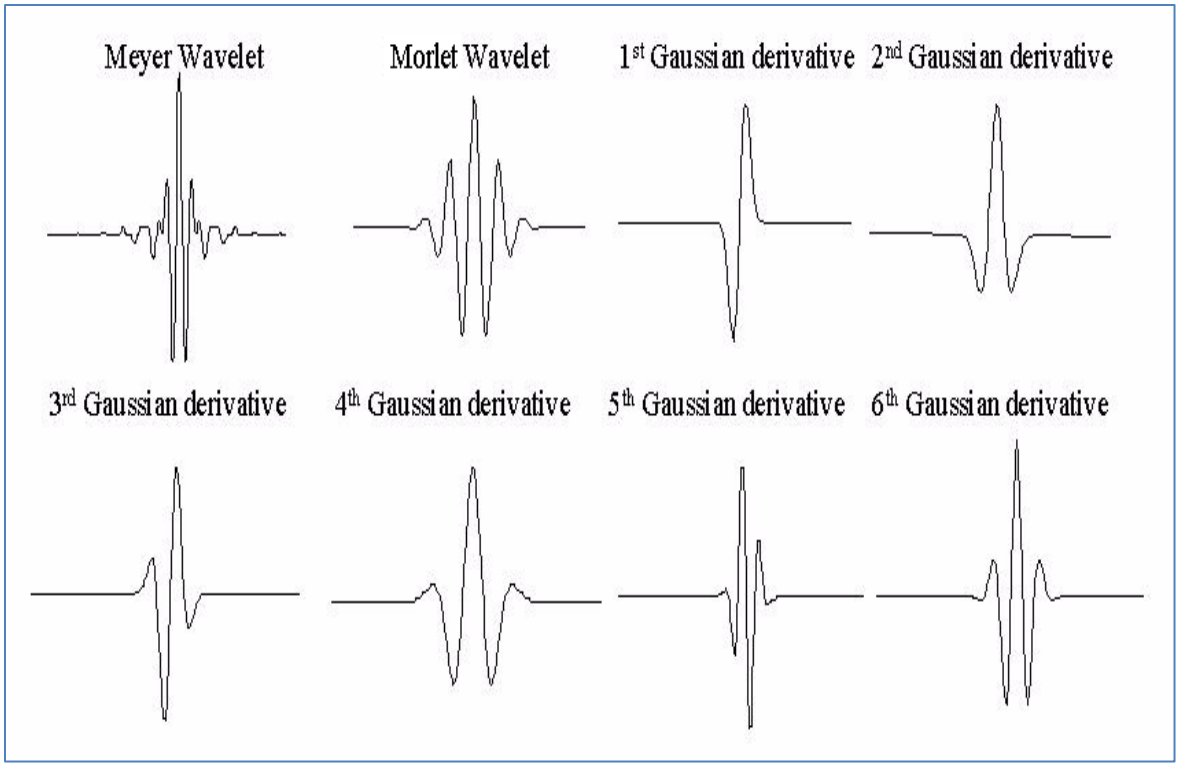

Figure 8 - Different wavelet functions used in ECG signal processing[20]

Advantages of using wavelet analysis of signal are -

1. By shifting and stretching a wavelet, it can be matched to the hidden events and accordingly we can find its frequency and area in time.

2. An imperative advantage or preference of a wavelet transform is that, dissimilar to an FFT, we can limit the wavelet coefficients for a just piece of the time.

3. The main advantage of using wavelet transform is that it allows us to analyse the different components of a signal that is non - stationary, while Fourier transform can't examine the non – stationary signal.

2.8 Different types of heart disease

- Tetraplegia
- Diabetic neuropathy
- Myocardial dysfunction
- Cardiac transplantation
- Peripheral arterial disease
- Coronary artery disease
- Pulmonary heart disease
- Myocardial dysfunction

2.9 How music affects cardiac physiology

Music has an enormous effect on the planet. Music can change our life's way, our theory of living, our soundness, solace, and unwinding. Dismal music and cheerful music can change our physiological state that is surveyed by skin conductance, heart rate, cerebrum action, facial EMG.

Music can help patients in diverse perspectives; for example, diminish the agony, the stresses and uneasiness before the surgery, the recovery period after the surgery, the reactions, and the span of treatment.

In present days, anxiety and nervousness have an extensive adverse effect on our general public and the vast majority of our infections start from psycho-physical issue. Hence decrease of stress is essential for the prosperity of our general public. Since music has an immediate association with human feeling and disposition, it can be utilized for the lessening of the anxiety of person.

A vital inquiry that may emerge right now is the way does music influence human physiological condition and what are the critical parameters expected to arrange the example? Amid the most recent two decades, the impact of distinctive sorts of music to advance unwinding has been examined all through the globe.

HRV is a mainstream non-invasive tool to know or survey distinctive heart conditions. Because of its non-intrusive or non- invasive character HRV has turned into an alluring device for its utilization in the investigation of human physiological reaction to diverse stimuli.

HRV is the variety of time between two successive heartbeats. It is a valuable tool to know the general cardiovascular wellbeing and the status of the autonomic nervous system (ANS).

At any moment, the watched HRV is a marker of the dynamic balance and harmony between the two branches of ANS (sympathetic and parasympathetic). Both the systems (sympathetic and parasympathetic) are dynamic and active with parasympathetic dominance in the state of normal and resting condition. The harmony between them is continually changing to upgrade the impact of all inside and outer stimuli.

In spite of the fact that the effects of music on brain are primarily acknowledged in mind through Central Nervous framework (C NS), music likewise influences the states of heart through the predominance of Para- sympathetic nerves of Autonomic Nervous system (ANS).

So it is no less vital to study the impact of music through investigation of HRV information that is extracted from the corresponding ECG signals of the heart.

2.10 Cardiac health and ANS

HRV is intelligent of the general condition of the prosperity of the organic entity. It is dominatingly reliant on the outward regulation of the Heart rate. HRV is thought to mirror the heart's capacity to adjust to changing circumstances by distinguishing and rapidly reacting to erratic stimuli.

8 Recent test affirmations for an association between a propensity for lethal arrhythmias and signs of either expanded thoughtful or decreased parasympathetic action has persuaded to the improvement of quantitative markers to pronounce the autonomic movement.

HRV speaks to one of these most powerful markers. It is a stable and free forecaster of death taking after an intense myocardial dead tissue.

It has been demonstrated in examination considers that amid the time of a mental or a passionate nervousness, an increment in the sympathetic movement and a concurrent diminishing in the parasympathetic action were watched, This outcomes in increased strain on the heart and in addition other imperative hormonal systems. The increment of sympathetic action is identified with a decreased ventricular fibrillation limit and in this manner an increased danger of fibrillation, rather than an increase in parasympathetic movement, which ensures the heart.

3. MATERIALS AND METHODS

INA128p (Texas Instruments), OP07 (Fairchild), disposable pre-gelled electrodes (BPL), Ni-MH 9V rechargeable batteries (UNIROS), and other electronic components were obtained from the local market. Data acquisition device (USB-6009) was obtained from National Instruments, USA.

3.1 Designing of ECG amplifier

An ECG amplifier was designed and developed using commercially available instrumentation amplifier (INA128p). The amplifier gain was set to 2500. An integrator was connected to the pin no. 5 of the instrumentation amplifier to remove any offset voltage.

The integrator was used to filter the output from instrumentation amplifier. With the help of two 10Ω resistances, Pin no. 8 and Pin no. 1 were connected to each other through the connecting nodes of resistances (10Ω), the signal was passed to a buffer.

The output of this integrator was used as the reference. The output of the INA128p was passed through a 2^{nd} – order low pass filter having the cut-off frequency of 160Hz so as to band limit the signal.

The schematic diagram of the ECG signal amplifier that was drawn in Multisim, has been shown in figure 9.

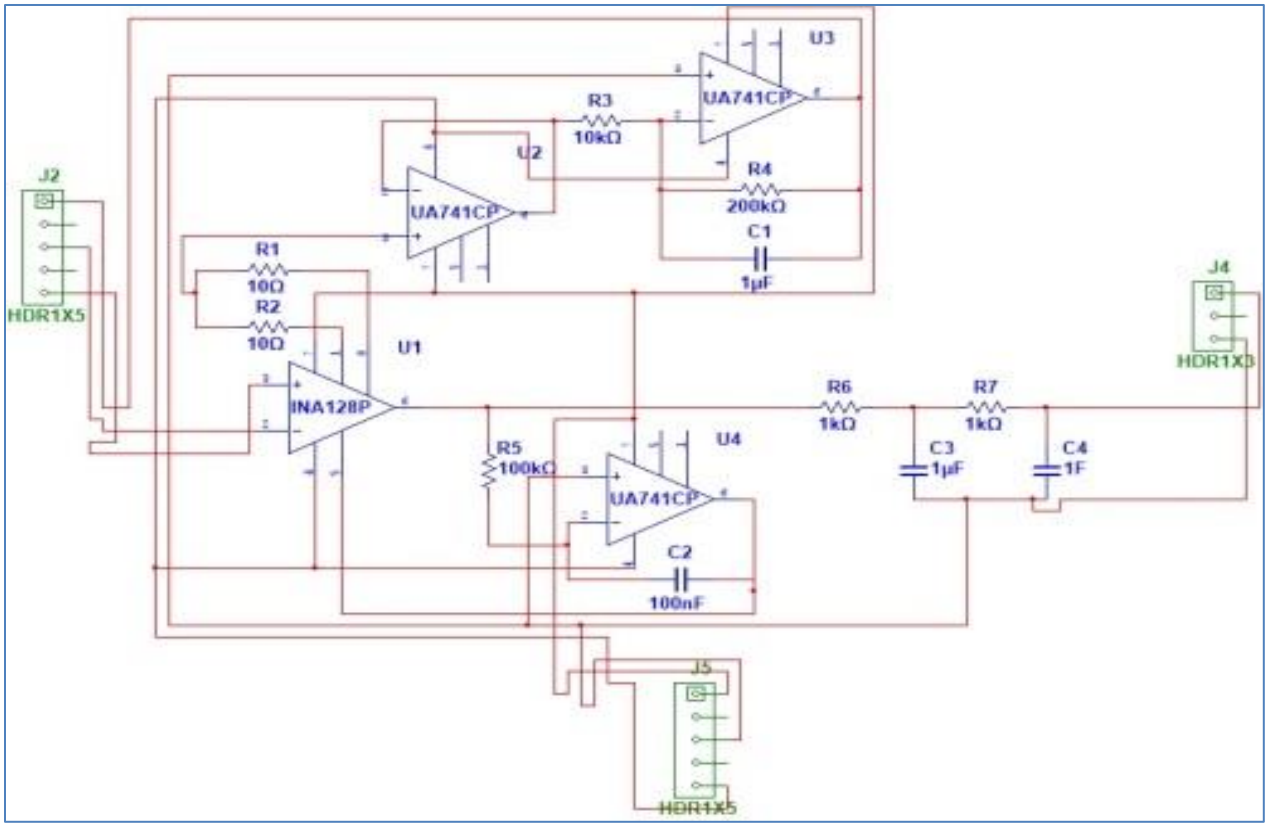

Figure 9 - Schematic diagram of the ECG amplifier circuit

3.2 Volunteers

Fifteen male volunteers in the age group of 22.2 ± 1.52 years were selected for the study. A consistence effort was made for excluding the smokers and athletes into the study. This was done to dispose of any autonomic sensory system mediations because of smoking or customary activity. Additionally, ECG signals were recorded no less than one week after mid-semester examination and two weeks prior to the begin of the end-semester examination. This was done to maintain a strategic distance from any nervousness and/or changed enthusiastic condition of the volunteers.

The ECG signal was gained from 9-11 pm, about an hour after supper in order to guarantee and keep up the consistency of the readings.

The volunteers were educated about the study and the methodology was verbally disclosed to them in subtle elements. If the volunteers agreed to take part in the study, they were requested to fill up an informed consent form.

Number of male volunteers – 15, AGE (Mean±SD) in years - 22.2±1.52

Weight (Mean±SD) in Kg – 66.78±10.98, Height (Mean±SD) in mt. – 1.74±0.07

3.3 Acquisition of ECG Signals

The ECG signals were acquired in a laptop using portable in housed developed ECG signal acquisition system. A suitable program was made using LabVIEW-2010 Software (National Instruments, USA).

The program was capable of acquiring the ECG signals and save the data in a text file for further analysis.

The volunteers were made to listen to slow music for 5 min. The ECG was recorded immediately after the stimulus was stopped.

After recording the readings in the computer, these readings can be saved in the text files and these text files can be used easily in any further analysis.

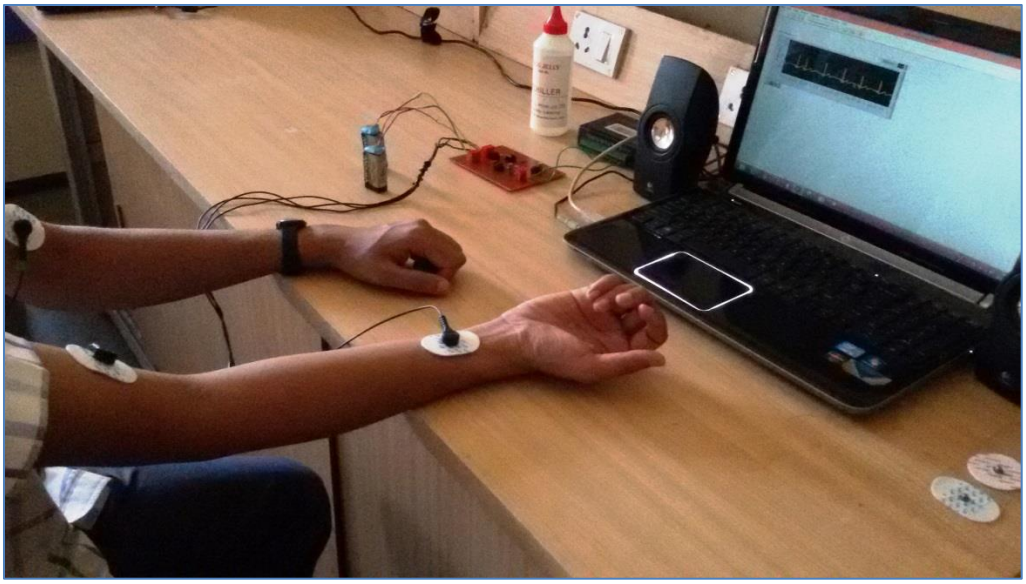

Figure 10 - ECG acquisition setup

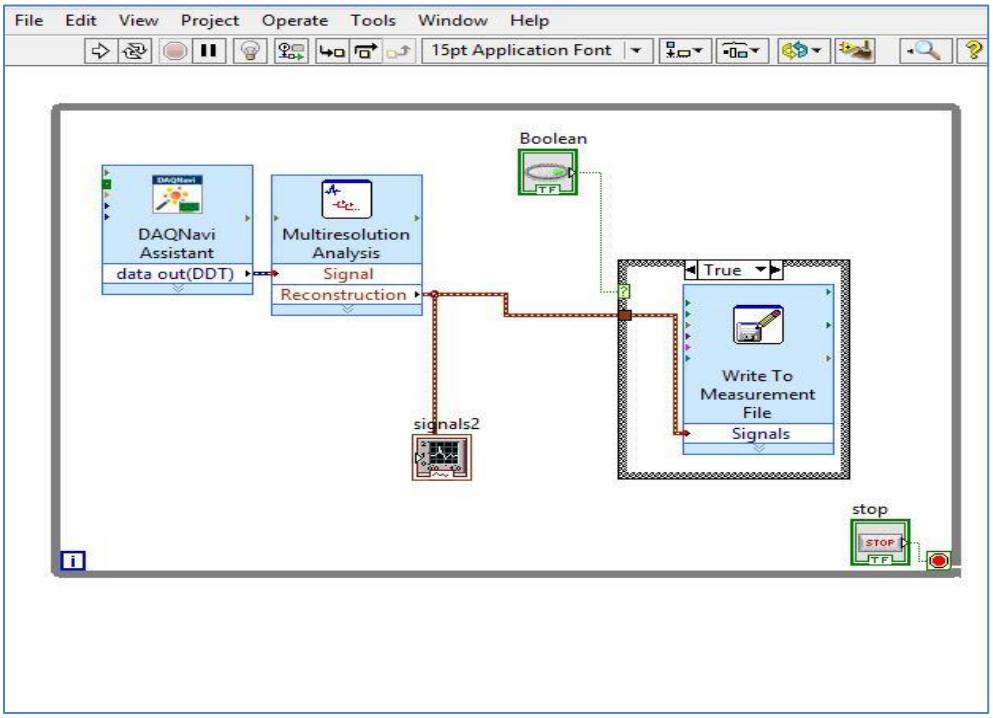

Figure 11 - Block diagram of LabView program for ECG acquisition

Figure 12 - Acquired ECG reading

3.4 HRV Analysis

The file of recorded ECG was imported into Biomedical Workbench Software (National Instruments, USA) provided by national instrument software. The R-peaks of the ECG signal were obtained. A band-pass filter (cut-off frequencies 10 Hz and 25 Hz) was used obtain the required signals. The determination of R-R intervals was done using the software and the output file was saved on the computer.

The saved file was used for the calculation of the HRV features.

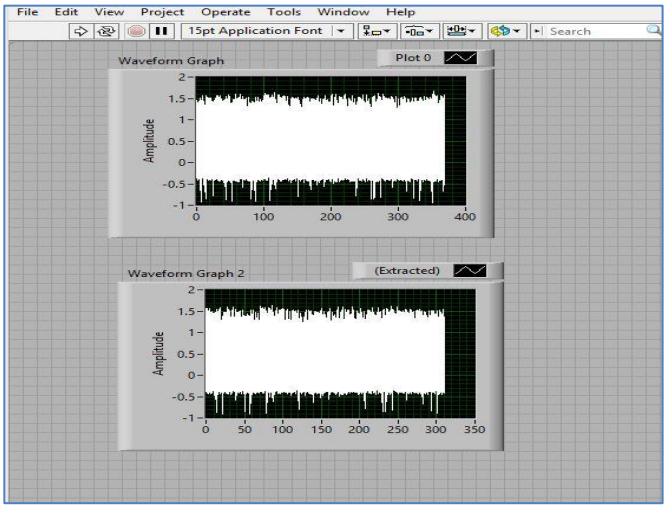

Figure 13 - 5 minute signal extraction for the HRV analysis

The HRV features were as follows:

- Statistical Measures (RRM, RRS, HRM, HRS, RMSSD, NN 50, p NN 50)
- Histogram Measures (RRTI (RR Triangular Index), TINN), Poincare Plot (Sd1, Sd2)
- FFT Spectrum (VLF po, LF po, HF po, VLF, LF, HF, LF norm, HF norm, LF/HF)
- AR Spectrum (VLF po, LF po, HF po, VLF, LF, HF, LF norm, HF norm, LF/HF).

  Here 'Po' is abbreviated as Power.

  RRM stands for RR Mean whereas, RRS stands for RR Std. and, so on [8] [9].

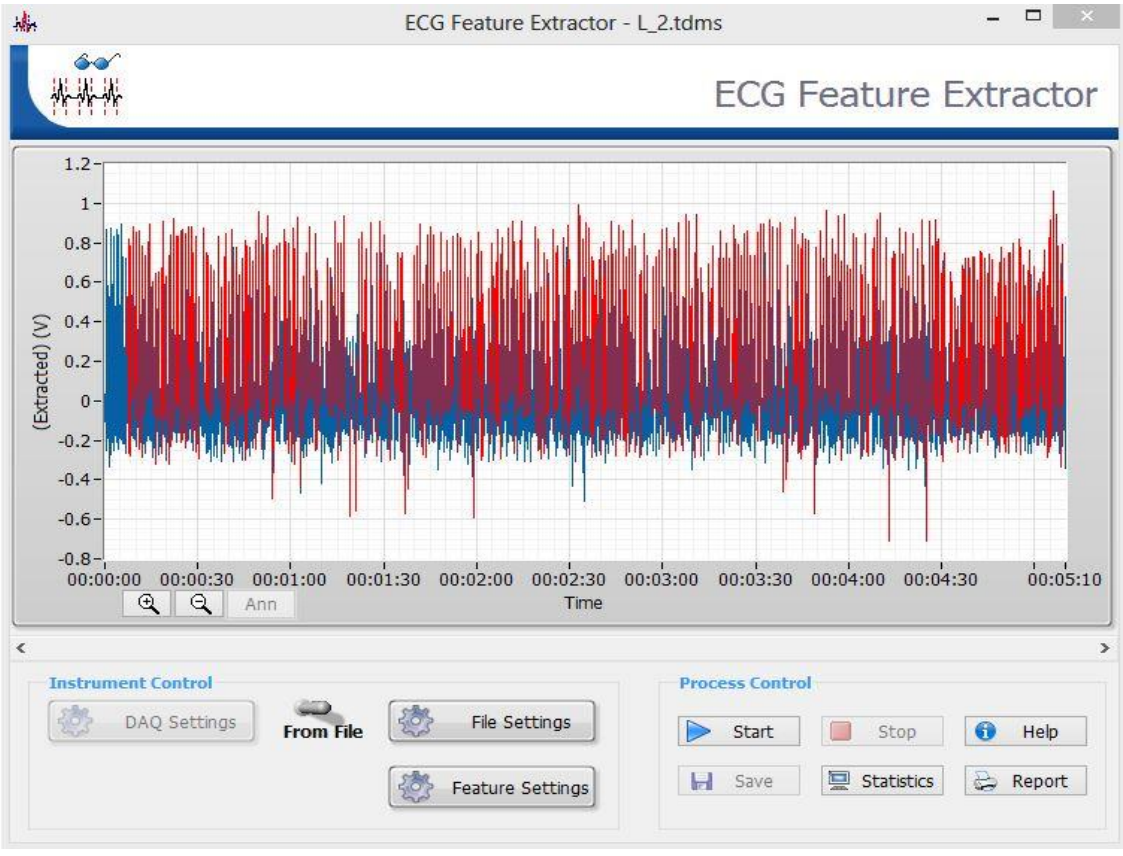

Figure 14 - ECG feature extractor (provided in biomedical workbench)

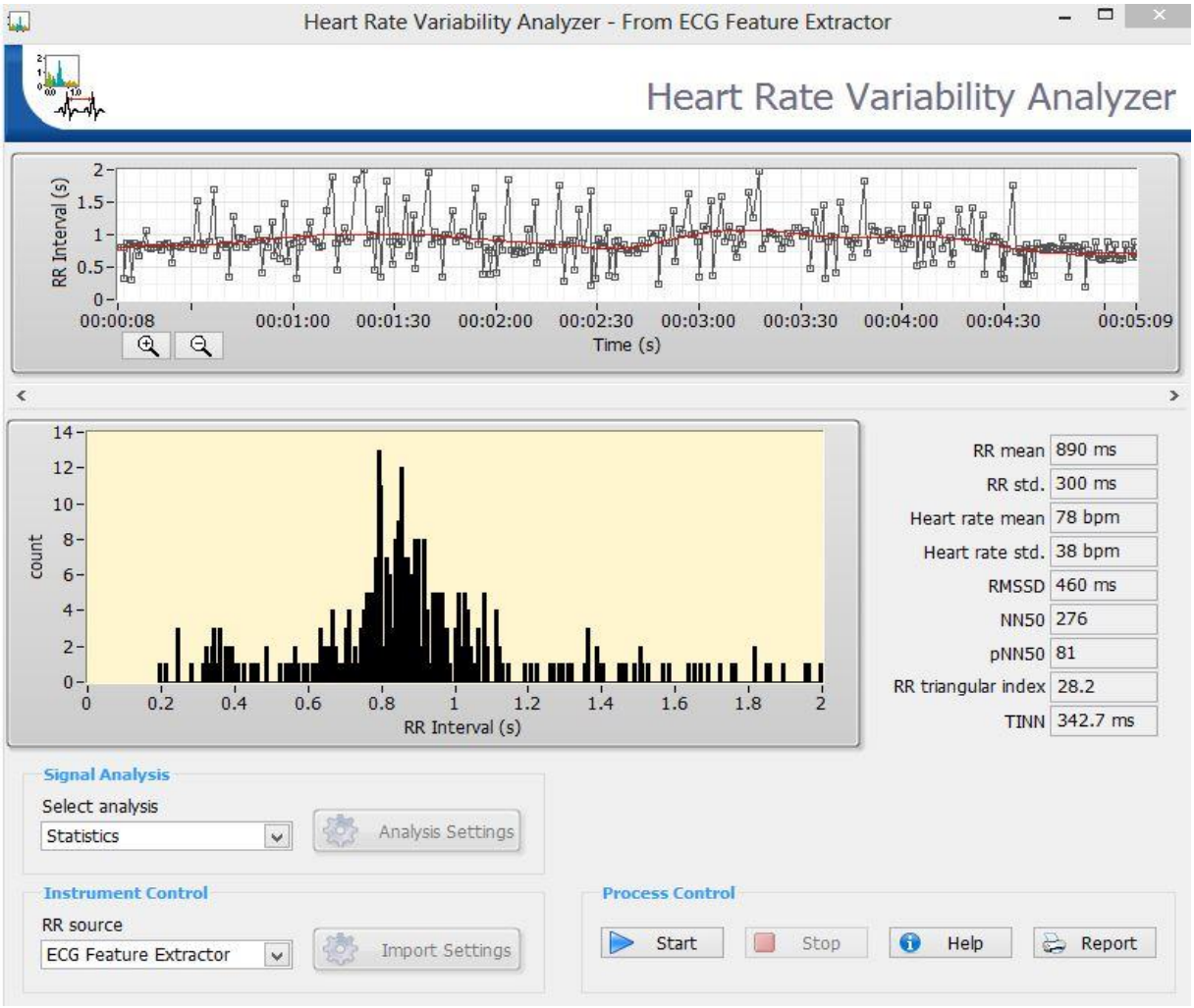

Figure 15 - Heart rate variability analyzer (provided in biomedical workbench)

4. RESULTS AND DISCUSSIONS

4.1 Designing of the ECG Amplifier

The layout of PCB of the ECG amplifier circuit was successfully created and developed in the NI Ultiboard 13.0 with the help of the circuit previously made in NI Multisim 13.0 (figure 19). After that, the ECG signal acquisition circuit was successfully implemented on the PCB (figure 20).

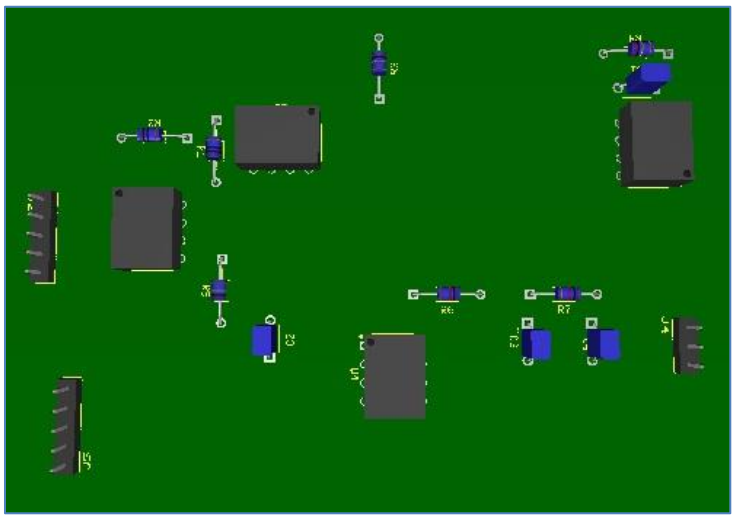

Figure 16 - 3D view of designed PCB layout in Ultiboard 13.0

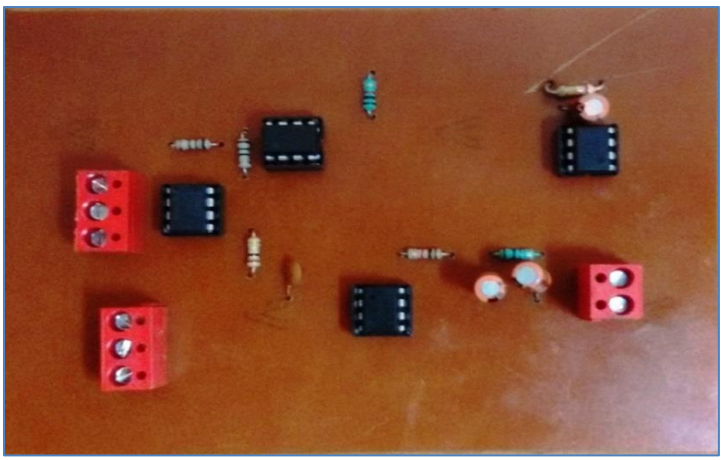

Figure 17 - Designed ECG amplifier circuit on PCB

The gain of the ECG amplifier was set to 2500. Using the designed PCB and the data acquisition system USB 4704, ECG signal was successfully acquired. The acquired ECG signal has been shown in the figure 21.

Figure 18 - The acquired ECG waveform

4.2 HRV Analysis

Heart Rate Variability (HRV) can be described as the physiological process, which is often utilised as a marker of the Autonomic Nervous System (ANS) activity [7]. This is because the ANS is responsible for modulating the activity of the SA node (present in the heart). The heart beat-to-beat changes can be obtained by monitoring the period of the RR intervals. The ANS can be partitioned into sympathetic and parasympathetic (vagal) systems. The sympathetic system has been known from the previous studies and literatures to increase the heart rate, whereas, the parasympathetic system do the opposite, means decreases the heart rate [8]. In this study, we

have observed that there was a decrement in the mean heart rate of the volunteers when they were subjected to the stimulus (music). The decrement in the heart rate was negligible when slow song stimulus was given. As discussed above, this indicated that listening to music increases parasympathetic activities.

Total 29 HRV parameters were obtained from the HRV feature extraction. To obtain the significant parameters from total parameters, analysis of variance (ANOVA) of obtained parameters was done. p-value <0.05, was used to determine the significant parameters. After The analysis of the HRV parameters using ANOVA, it was found that only NN50 & pNN50 were significantly different features. These NN50 & pNN50 are the time domain features of the HRV analysis of ECG signal.

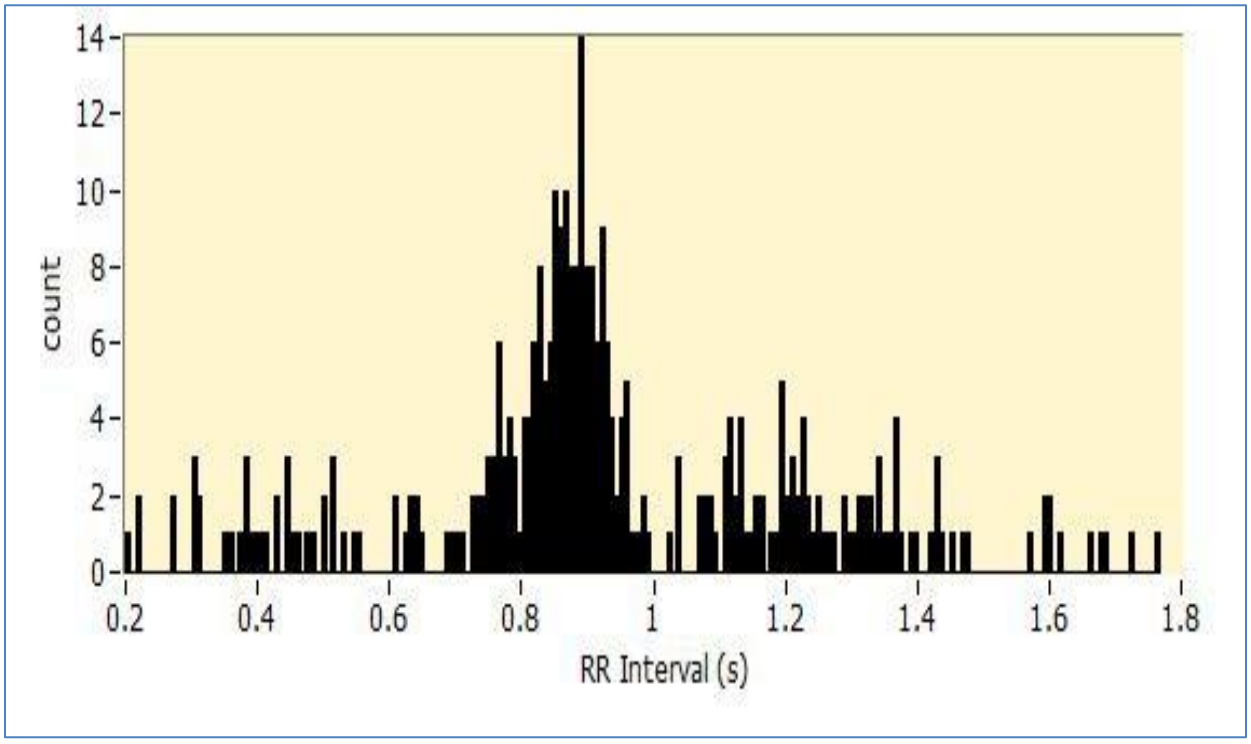

Figure 19 - Histogram plot of RR intervals

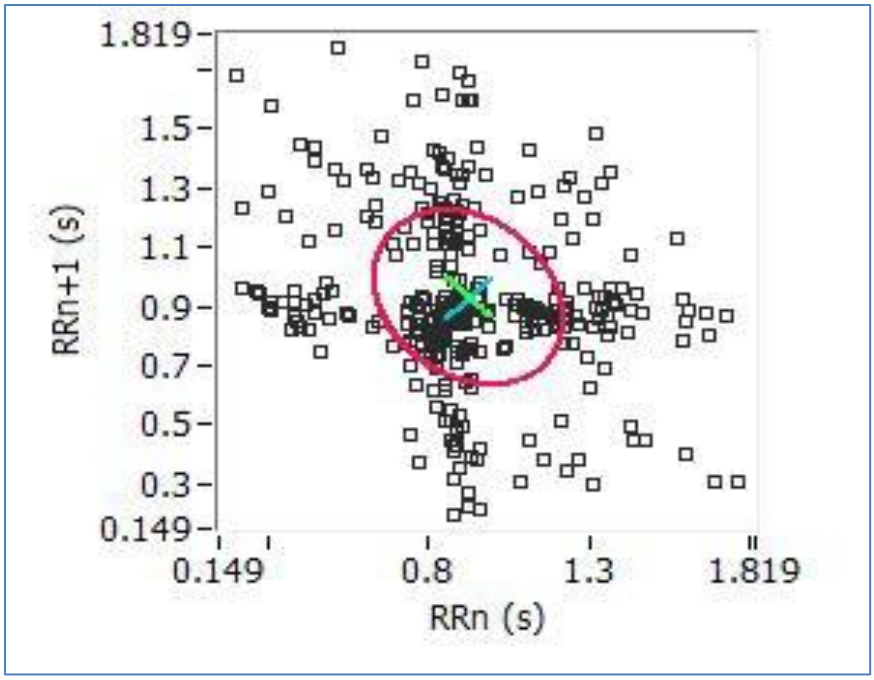

Figure 20 - Poincare plot

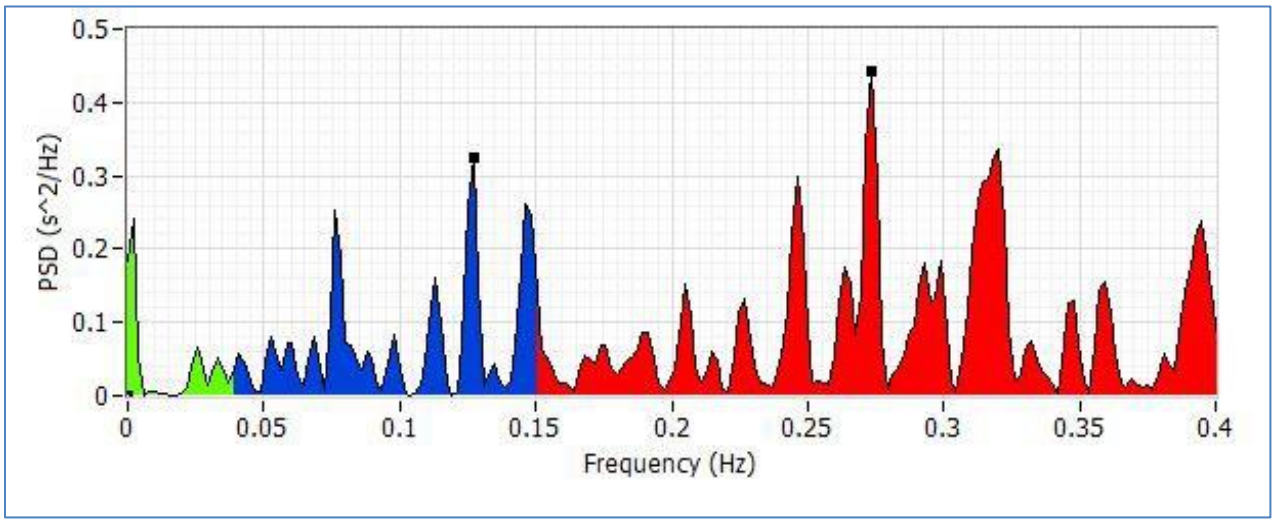

Figure 21 – FFT spectrum given in heart rate variability analyzer report

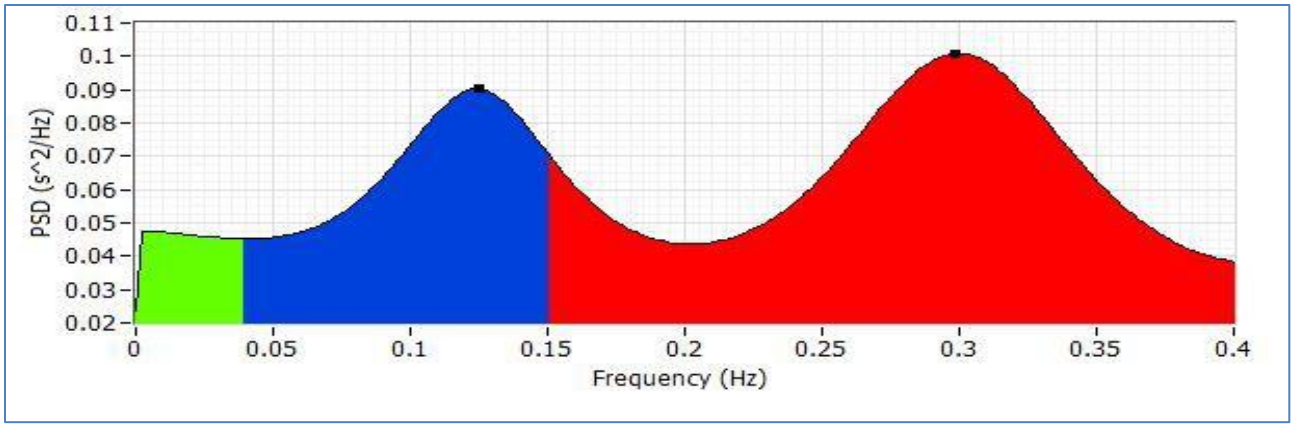

Figure 22 - AR spectrum given in heart rate variability analyzer report

Below are the FFT spectrogram and Gabor spectrogram obtained from the heart rate variability analyzer. First image is of the FFT spectrogram and second image is of the Gabor spectrogram.

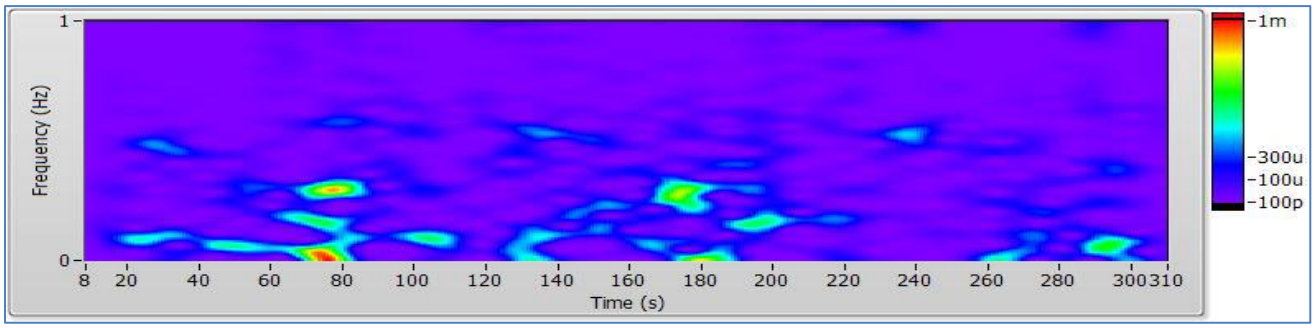

Figure 23 - FFT spectrogram obtained from the heart rate variability

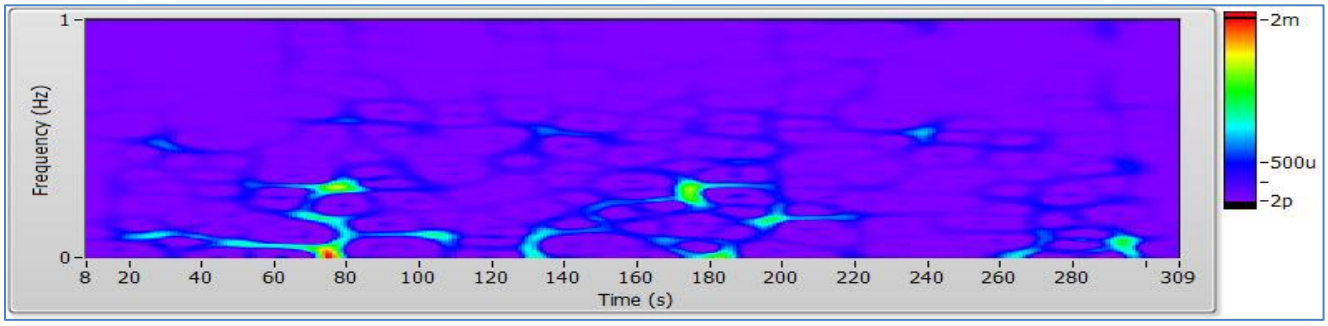

Figure 24 - Gabor spectrogram obtained from the heart rate variability analyzer

The Mean±SD of the important HRV parameters obtained from analysis of variance (ANOVA), along with their p-values are provided in table-1 given below.

Table-1

IMPORTANT PREDICTORS FROM HRV FEATURES

Classifiers	**HRV Features**	**Slow music**	**p- value**
		Mean±SD	
ANOVA	NN50	306.867±28.334	0.027207
	pNN50	78.333±4.047	0.000001

5. CONCLUSION

Due to increased instances of cardiovascular diseases in the present scenario, it is much needed to develop the efficient and cost effective cardiovascular monitoring devices. In our study, we focused on to design and develop an ECG acquisition circuit that was used further in our study of the effect of slow music on cardiac physiology and autonomic nervous system.

The ECG acquisition circuit was successfully designed and developed. It was successfully used further in the study of the effect of slow music on cardiac physiology. The designed circuit was successfully functioning, and the gain of the ECG amplifier was set to 2500.

The use of music in altering the emotional state of patients is being studied by many researchers [14]. Many scientists have reported that listening of music results in the increase in parasympathetic dominance due to the increased vagal activity. In our study, we have tried to determine the alteration in the ANS activity by making the volunteers listen to slow music. A marginal increase in the parasympathetic dominance was observed when the volunteers listened to the slow music. NN50 & pNN50 were found to be statistically significant. NN50 & pNN50 are associated with the variation in the RR intervals. This means that they might provide information about the conduction pathway of the heart. Hence, it can be assumed that the listening of music alters the ANS activity. In spite of the fact that the outcomes acquired in this study are empowering, the study must be directed on a bigger gathering of volunteers for the acceptance of the outcomes. The accurate alteration in the physiological changes of the conduction pathway of the heart must be contemplated top to bottom. This investigation was out of the extent of this study and will be analyzed later on course of time.

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Appendices

DEPARTMENT OF BIOTECHNOLOGY & MEDICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA

EFFECT OF FAST&SLOW MUSIC ON THE PHYSIOLOGY OF HEART
Volunteers History& Consent Form

NUMBER: **Date:**

1. General Information

1. Name (Mr./Ms/Mrs.)_____
2. Date Of Birth _____Age_____
3. Address_____
   _____
   _____
4. Contact No _____E-Mail _____
5. Body Weight (kg)_____Height (mt)_____BMI (kg/m^2)_____

2. Medical information

1. Medical History

*a) None*_____

*b) Specify If Any*_____

2. Surgical History

*a) None*_____

*b) Specify If Any*_____

3. Gynecological Problem

a) None _____

b) Specify If Any _____

4. Drug History

a) None _____

*b) Specify If Any*_____

5. Sleeping Disorder

a) None _____

*b) Specify If Any*_____

6. Appetite

*a) None*_____

*b) Specify If Any*_____

7. Diet Habit

a) Vegetarian _____

*b) Non-Vegetarian*_____

*c) Eggetarian*_____

DEPARTMENT OF BIOTECHNOLOGY & MEDICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA

3. Habitual information

Exercise

a) Yes _____

b) No _____

c) If Yes, What Type_____

d) Frequency And Activity

i) Regularly_____

ii) Weekly _____

iii) Rarely _____

Any other comments you may want to make:_____

_____

Declaration:

I Mr. /Miss. _____ hereby declare that I have been verbally made aware about the details of the study and the risk involved in it. I give my consent to the below-mentioned researchers to acquire and analyze the ECG signal. I understand that the results obtained from the analysis of the ECG signals acquired will be used to compile a report which will lead to the B.Tech thesis dissertation of MrRudraDuttShukla. I also give my consent to them to use the results for writing scientific manuscripts and dissemination to the scientific world either digitally or in print-form.

.....
Signature of the participant with date

Researchers involved in the study

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